FIG. 1

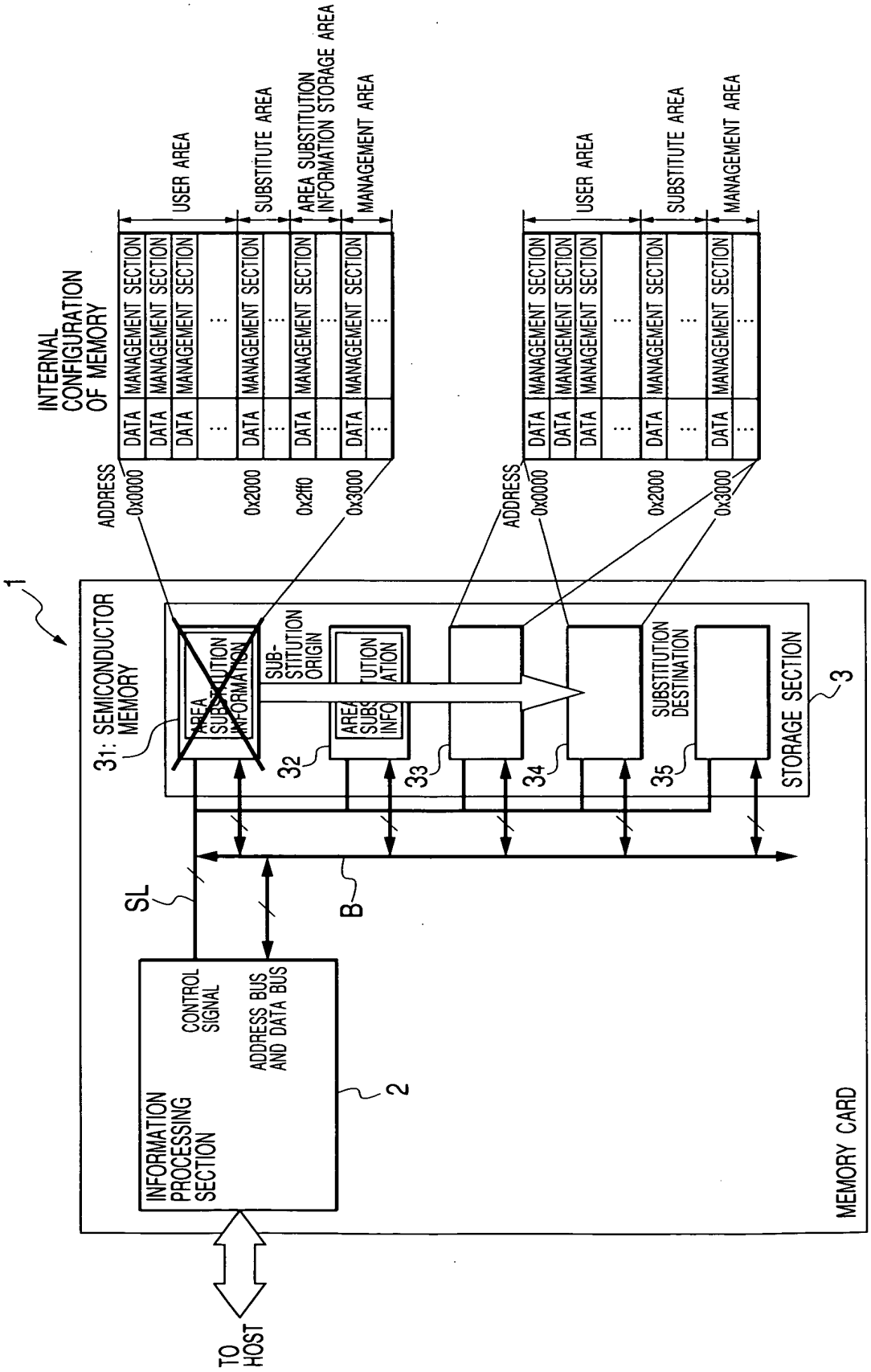

MEMORY CARD
1
31: SEMICONDUCTOR MEMORY
STORAGE SECTION
3
SUBSTITUTION DESTINATION
SUB-STITUTION ORIGIN
AREA SUBSTITUTION INFORMATION
32
33
34
35
SL
B
INFORMATION PROCESSING SECTION
2
CONTROL SIGNAL
ADDRESS BUS AND DATA BUS
TO HOST
INTERNAL CONFIGURATION OF MEMORY
ADDRESS
0x0000
0x2000
0x2ff0
0x3000
USER AREA
SUBSTITUTE AREA
AREA SUBSTITUTION INFORMATION STORAGE AREA
MANAGEMENT AREA
DATA
MANAGEMENT SECTION

FIG. 2

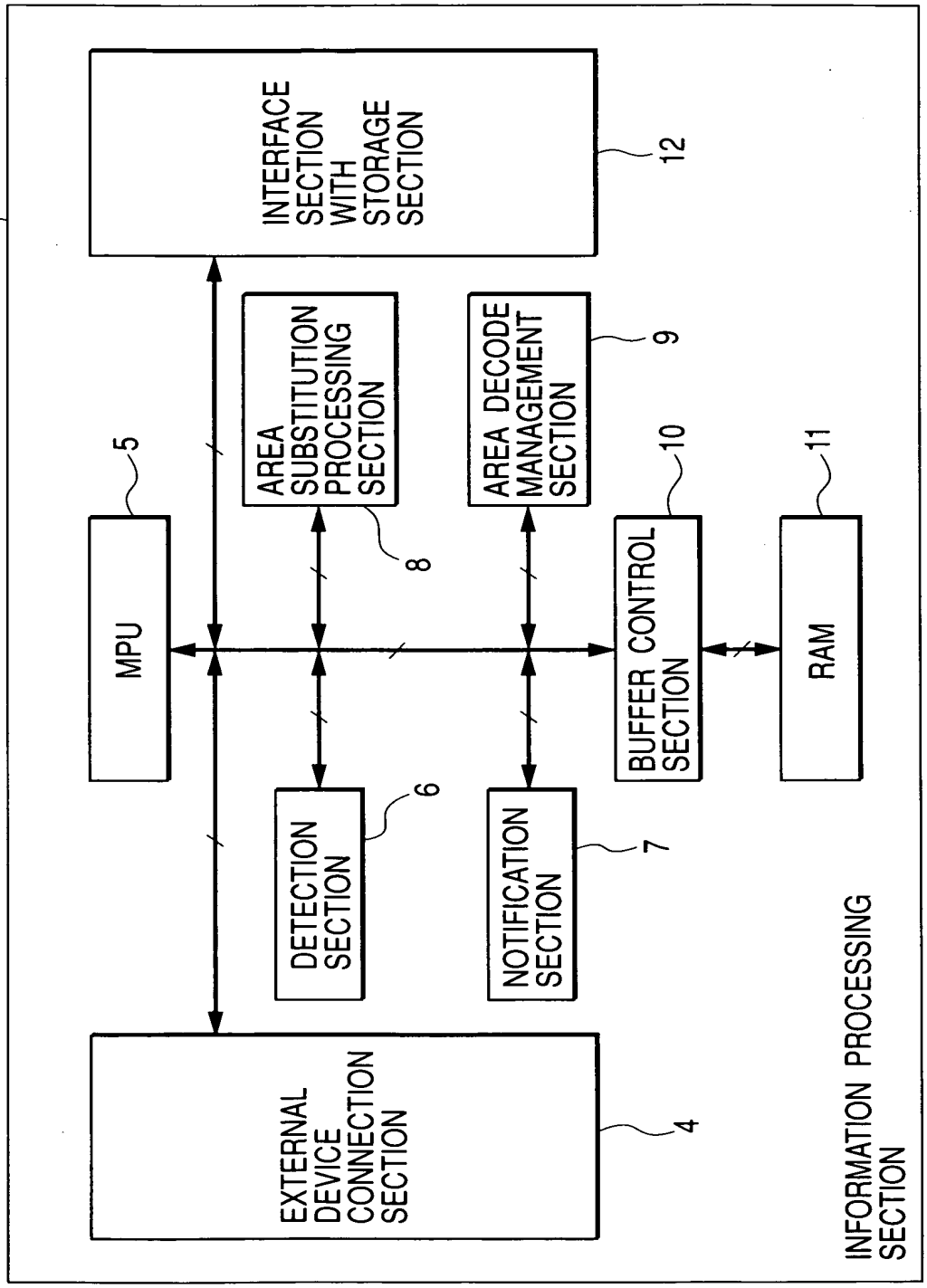

2
INFORMATION PROCESSING SECTION
INTERFACE SECTION WITH STORAGE SECTION
12
MPU
5
AREA SUBSTITUTION PROCESSING SECTION
8
AREA DECODE MANAGEMENT SECTION
9
BUFFER CONTROL SECTION
10
RAM
11
DETECTION SECTION
6
NOTIFICATION SECTION
7
EXTERNAL DEVICE CONNECTION SECTION
4

FIG. 3

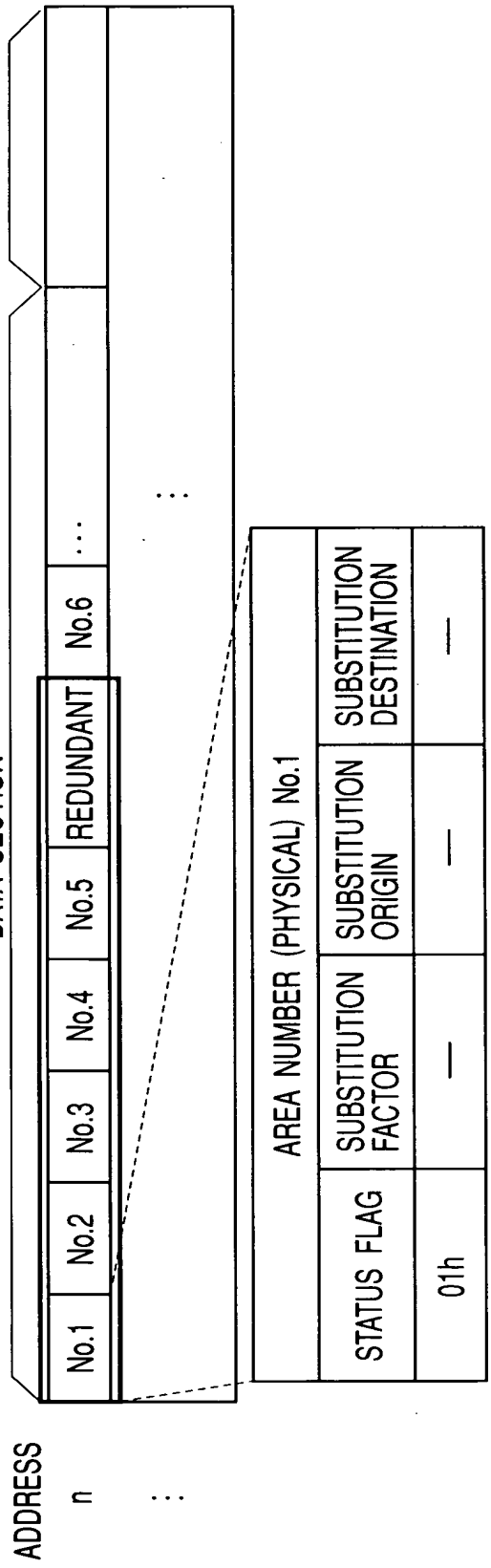

ADDRESS
n
...
DATA SECTION
MANAGEMENT SECTION
No.1
No.2
No.3
No.4
No.5
REDUNDANT
No.6
...
AREA NUMBER (PHYSICAL) No.1
STATUS FLAG
SUBSTITUTION FACTOR
SUBSTITUTION ORIGIN
SUBSTITUTION DESTINATION
01h
—
—
—

FIG. 4

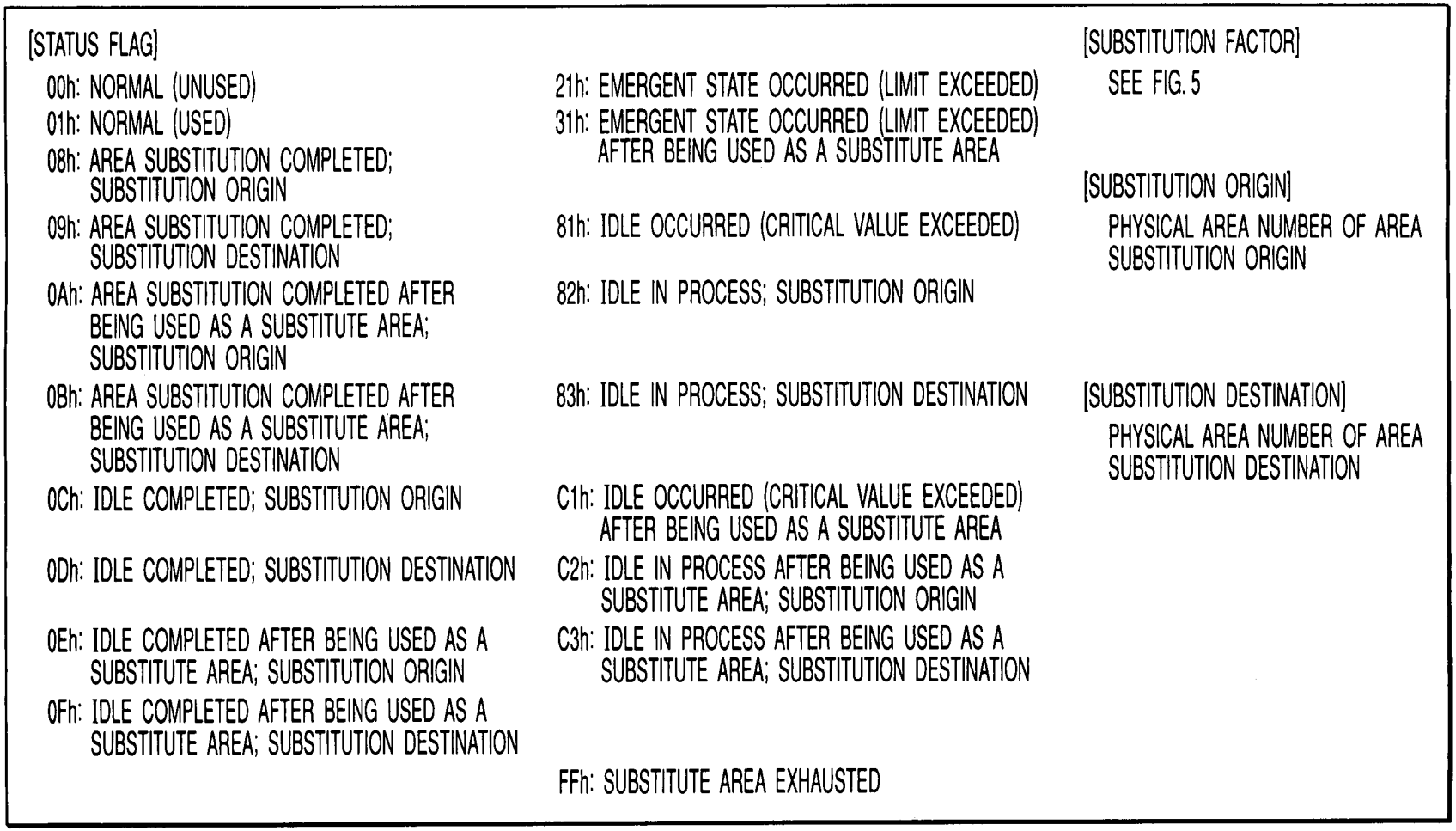
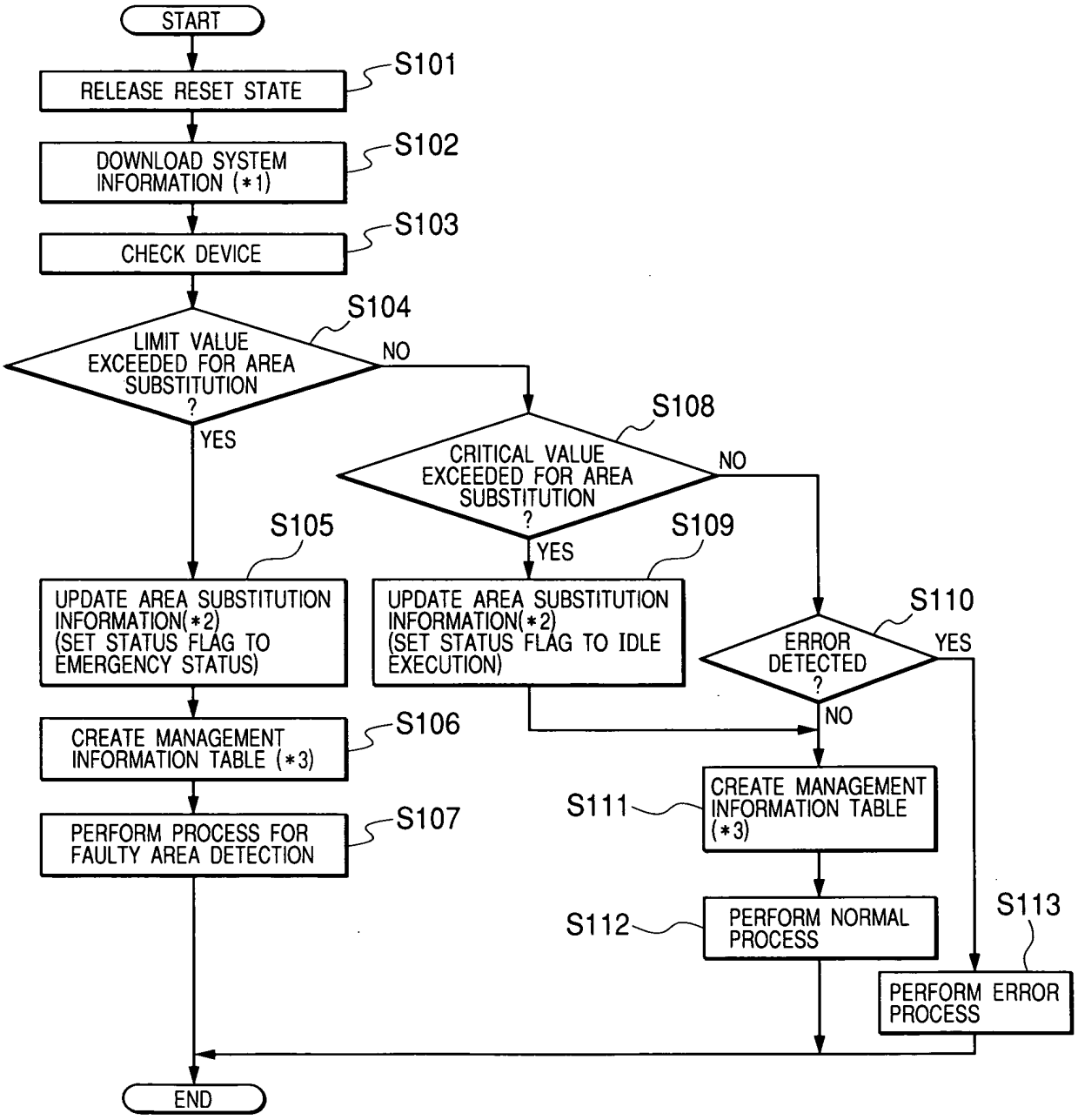

[STATUS FLAG]
00h: NORMAL (UNUSED)
01h: NORMAL (USED)
08h: AREA SUBSTITUTION COMPLETED; SUBSTITUTION ORIGIN
09h: AREA SUBSTITUTION COMPLETED; SUBSTITUTION DESTINATION
0Ah: AREA SUBSTITUTION COMPLETED AFTER BEING USED AS A SUBSTITUTE AREA; SUBSTITUTION ORIGIN
0Bh: AREA SUBSTITUTION COMPLETED AFTER BEING USED AS A SUBSTITUTE AREA; SUBSTITUTION DESTINATION
0Ch: IDLE COMPLETED; SUBSTITUTION ORIGIN
0Dh: IDLE COMPLETED; SUBSTITUTION DESTINATION
0Eh: IDLE COMPLETED AFTER BEING USED AS A SUBSTITUTE AREA; SUBSTITUTION ORIGIN
0Fh: IDLE COMPLETED AFTER BEING USED AS A SUBSTITUTE AREA; SUBSTITUTION DESTINATION
21h: EMERGENT STATE OCCURRED (LIMIT EXCEEDED)
31h: EMERGENT STATE OCCURRED (LIMIT EXCEEDED) AFTER BEING USED AS A SUBSTITUTE AREA
81h: IDLE OCCURRED (CRITICAL VALUE EXCEEDED)
82h: IDLE IN PROCESS; SUBSTITUTION ORIGIN
83h: IDLE IN PROCESS; SUBSTITUTION DESTINATION
C1h: IDLE OCCURRED (CRITICAL VALUE EXCEEDED) AFTER BEING USED AS A SUBSTITUTE AREA
C2h: IDLE IN PROCESS AFTER BEING USED AS A SUBSTITUTE AREA; SUBSTITUTION ORIGIN
C3h: IDLE IN PROCESS AFTER BEING USED AS A SUBSTITUTE AREA; SUBSTITUTION DESTINATION
FFh: SUBSTITUTE AREA EXHAUSTED
[SUBSTITUTION FACTOR]
SEE FIG. 5
[SUBSTITUTION ORIGIN]
PHYSICAL AREA NUMBER OF AREA SUBSTITUTION ORIGIN
[SUBSTITUTION DESTINATION]
PHYSICAL AREA NUMBER OF AREA SUBSTITUTION DESTINATION

FIG. 5

AREA SUBSTITUTION FACTOR		SUBSTITUTION FACTOR VALUE	LIMIT VALUE	CRITICAL VALUE	RETRY REQUIRED ?
SUBSTITUTE FREE AREA		1h	0	20 BLOCKS OR LESS	—
SUCCESSIVE RETRY ERROR	SUCCESSIVE PROGRAM ERROR	2h	260 TIMES OR MORE	10 TIMES OR MORE	REQUIRED
	EXCESSIVE WRITE ERROR	3h	260 TIMES OR MORE	10 TIMES OR MORE	REQUIRED
	RETENTION FAILURE (VERIFY CHECK ERROR)	4h	260 TIMES OR MORE	10 TIMES OR MORE	REQUIRED
ECC UNCORRECTABLE ERROR AT RETENTION FAILURE		5h	ONCE	—	—
DEVICE/MANUFACTURE CODE UNREADABLE ERROR		6h	ONCE	—	—
PHYSICAL AMOUNT	ERASURE/PROGRAM TIME	7h	100ms	10ms	—
	NUMBER OF ERASURES	8h	1M TIMES	300K TIMES	—
	READ CURRENT VALUE	9h	1.2A OR MORE	700mA OR MORE	—
	WRITE CURRENT VALUE	Ah	1.5A OR MORE	1.0A OR MORE	—
	EXTERNALLY SUPPLIED POWER/CURRENT VALUE	Bh	3A OR MORE	1.5A OR MORE	—

FIG. 6



(*1): DOWNLOAD THE SYSTEM INFORMATION CONTAINING AREA SUBSTITUTION INFORMATION TO THE WORK AREA.
REFERENCE THE AREA SUBSTITUTION INFORMATION TO AVOID A FAULTY CHIP, AND DOWNLOAD THE SYSTEM INFORMATION

(*2): UPDATE ONLY DATA IN THE WORK AREA

(*3): REFERENCE THE AREA SUBSTITUTION INFORMATION TO AVOID A FAULTY AREA, AND CREATE A TABLE BASED ON THE MANAGEMENT AREA INFORMATION IN THE MEMORY

FIG. 7

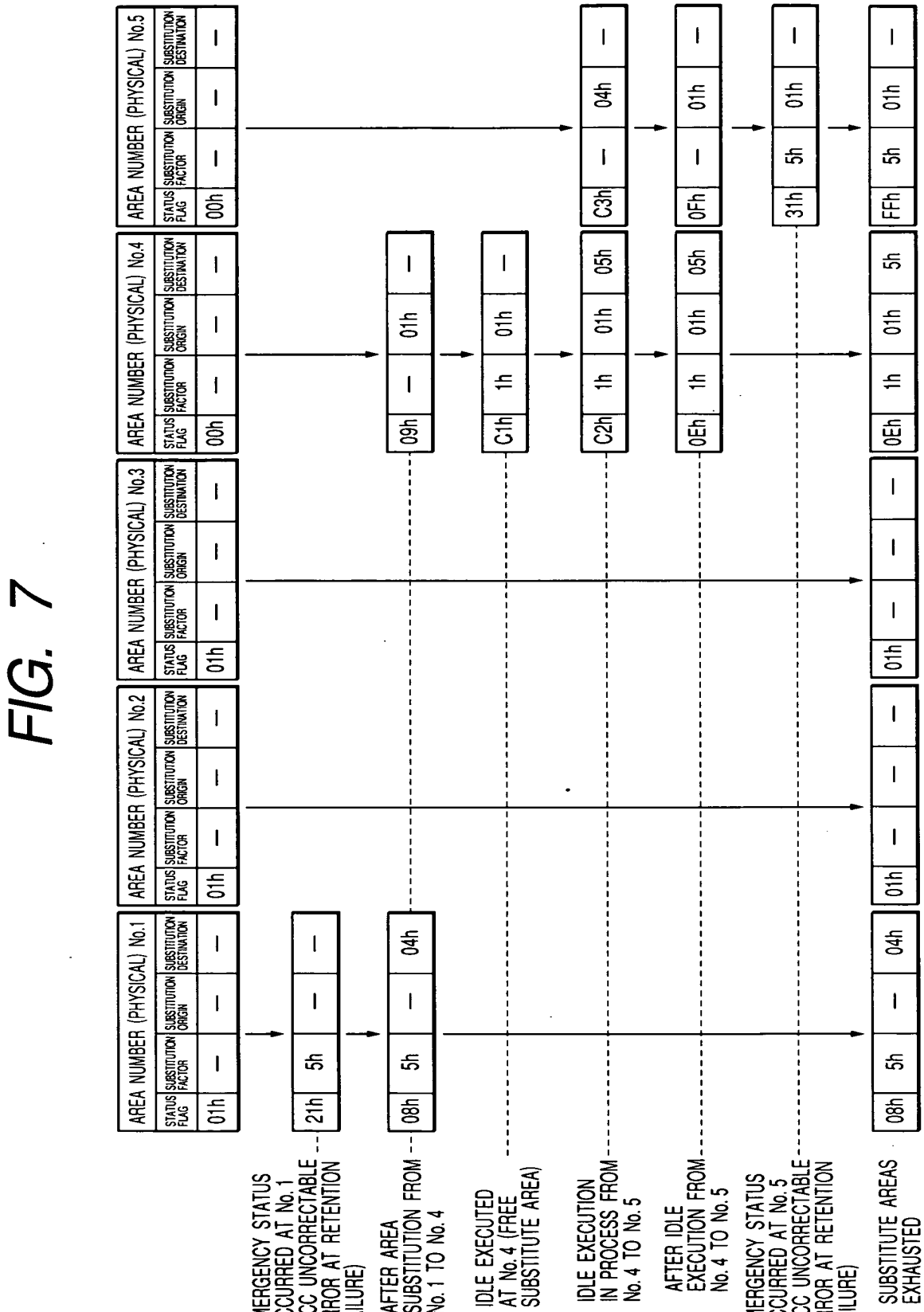

AREA NUMBER (PHYSICAL) No.1
AREA NUMBER (PHYSICAL) No.2
AREA NUMBER (PHYSICAL) No.3
AREA NUMBER (PHYSICAL) No.4
AREA NUMBER (PHYSICAL) No.5
STATUS FLAG
SUBSTITUTION FACTOR
SUBSTITUTION ORIGIN
SUBSTITUTION DESTINATION
EMERGENCY STATUS OCCURRED AT No. 1 (ECC UNCORRECTABLE ERROR AT RETENTION FAILURE)
AFTER AREA SUBSTITUTION FROM No. 1 TO No. 4
IDLE EXECUTED AT No. 4 (FREE SUBSTITUTE AREA)
IDLE EXECUTION IN PROCESS FROM No. 4 TO No. 5
AFTER IDLE EXECUTION FROM No. 4 TO No. 5
EMERGENCY STATUS OCCURRED AT No. 5 (ECC UNCORRECTABLE ERROR AT RETENTION FAILURE)
SUBSTITUTE AREAS EXHAUSTED

FIG. 8

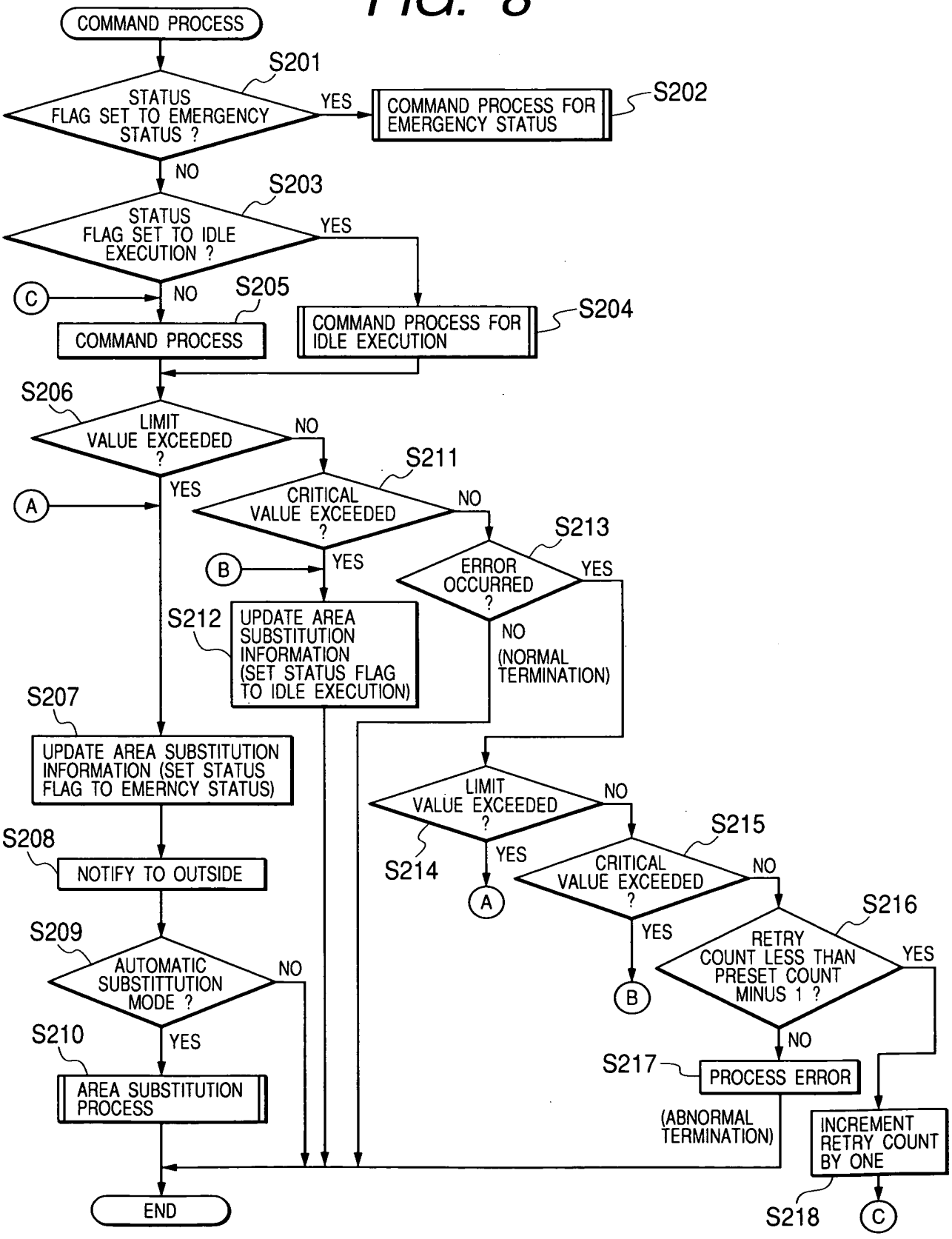

COMMAND PROCESS
S201
STATUS FLAG SET TO EMERGENCY STATUS ?
YES
COMMAND PROCESS FOR EMERGENCY STATUS
S202
NO
S203
STATUS FLAG SET TO IDLE EXECUTION ?
YES
C
NO
S205
COMMAND PROCESS
COMMAND PROCESS FOR IDLE EXECUTION
S204
S206
LIMIT VALUE EXCEEDED ?
NO
S211
A
YES
CRITICAL VALUE EXCEEDED ?
NO
S213
B
YES
ERROR OCCURRED ?
YES
S212
UPDATE AREA SUBSTITUTION INFORMATION (SET STATUS FLAG TO IDLE EXECUTION)
NO (NORMAL TERMINATION)
S207
UPDATE AREA SUBSTITUTION INFORMATION (SET STATUS FLAG TO EMERNCY STATUS)
LIMIT VALUE EXCEEDED ?
NO
S215
S208
NOTIFY TO OUTSIDE
S214
YES
CRITICAL VALUE EXCEEDED ?
NO
A
S216
S209
AUTOMATIC SUBSTITTUTION MODE ?
NO
YES
B
RETRY COUNT LESS THAN PRESET COUNT MINUS 1 ?
YES
S210
YES
NO
S217
AREA SUBSTITUTION PROCESS
PROCESS ERROR
(ABNORMAL TERMINATION)
INCREMENT RETRY COUNT BY ONE
END
S218
C

FIG. 9

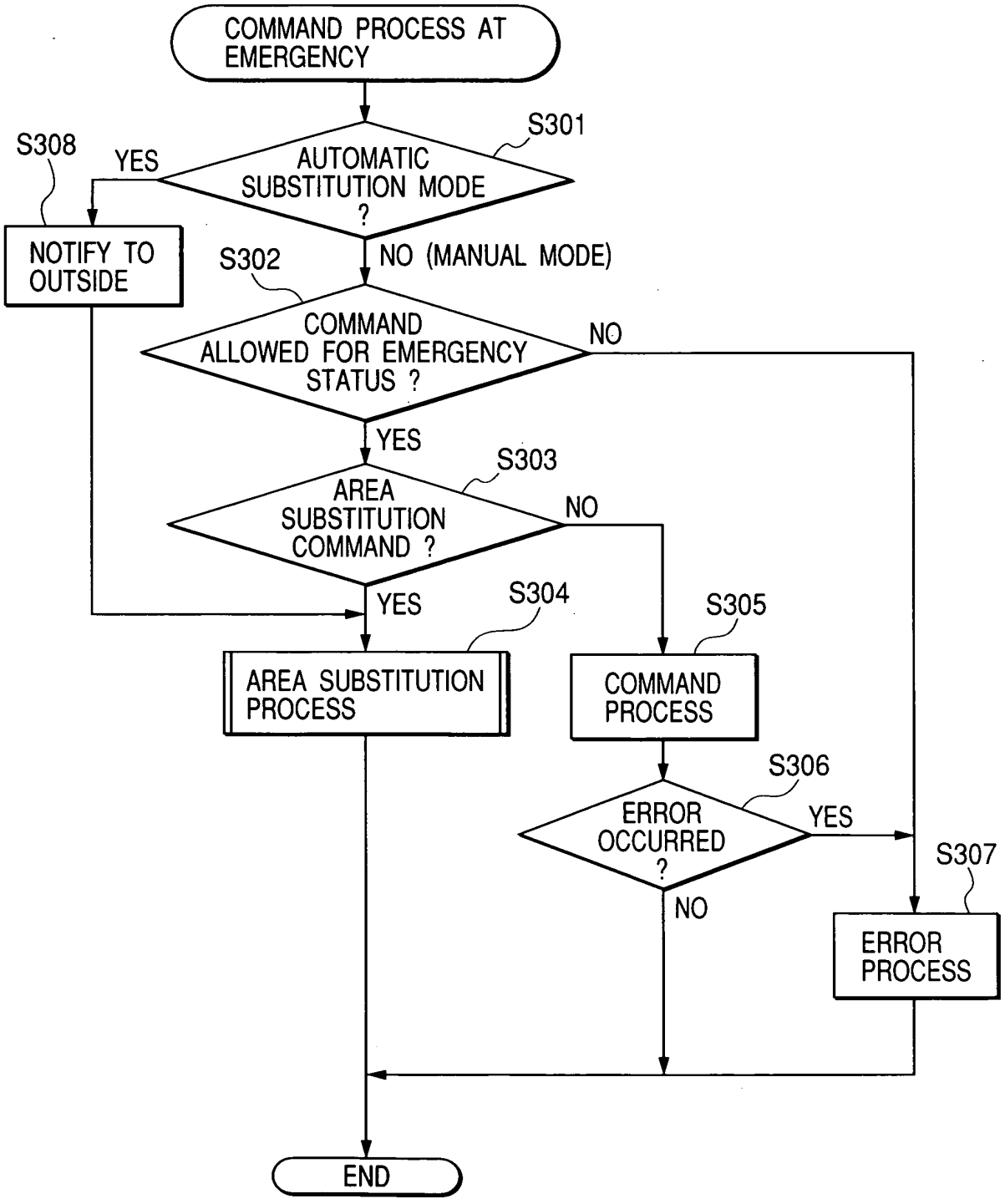

COMMAND PROCESS AT EMERGENCY
S301
AUTOMATIC SUBSTITUTION MODE ?
S308
YES
NOTIFY TO OUTSIDE
NO (MANUAL MODE)
S302
COMMAND ALLOWED FOR EMERGENCY STATUS ?
NO
YES
S303
AREA SUBSTITUTION COMMAND ?
NO
YES
S304
AREA SUBSTITUTION PROCESS
S305
COMMAND PROCESS
S306
ERROR OCCURRED ?
YES
NO
S307
ERROR PROCESS
END

FIG. 10

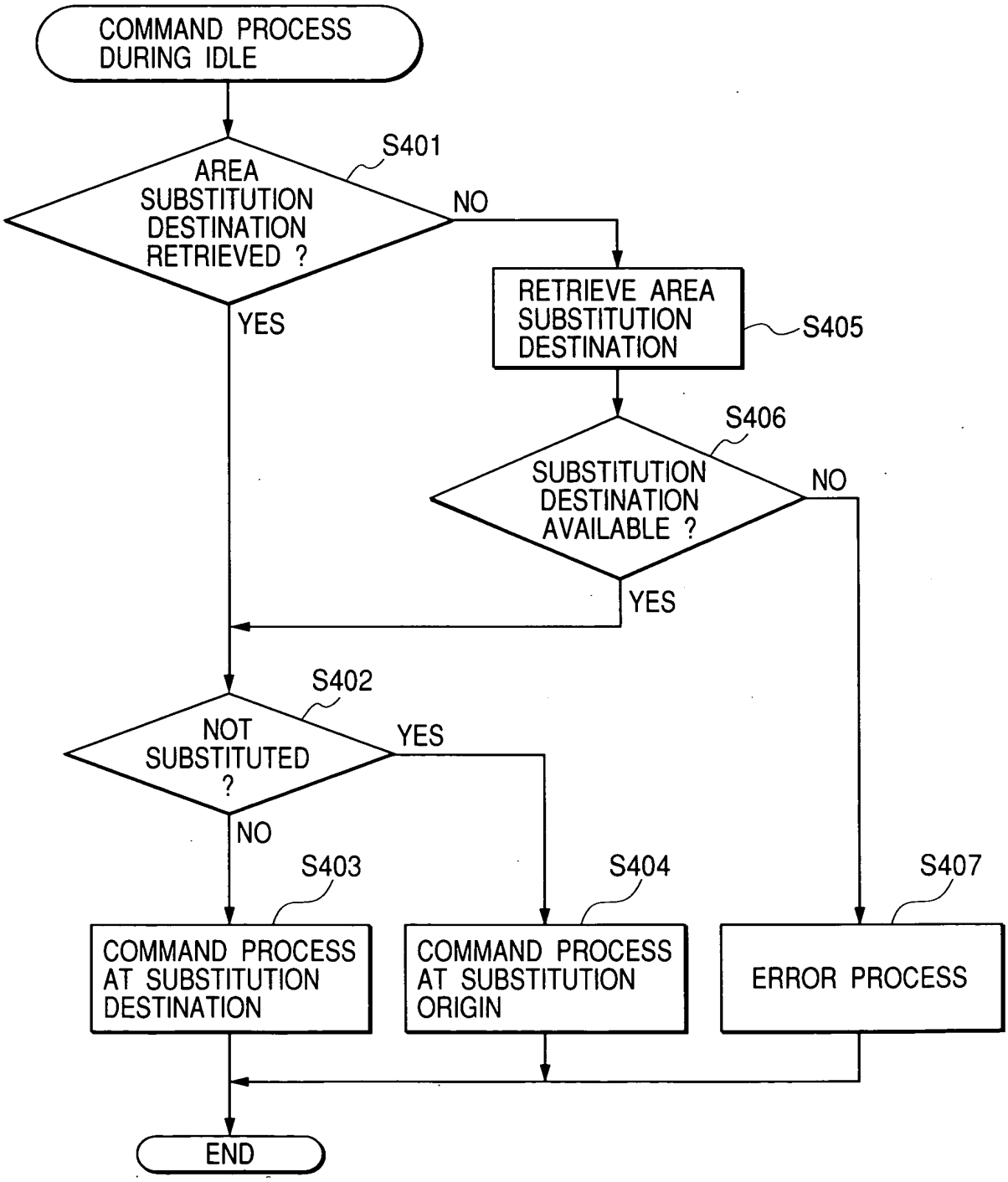

COMMAND PROCESS DURING IDLE
S401
AREA SUBSTITUTION DESTINATION RETRIEVED ?
NO
YES
RETRIEVE AREA SUBSTITUTION DESTINATION
S405
S406
SUBSTITUTION DESTINATION AVAILABLE ?
NO
YES
S402
NOT SUBSTITUTED ?
YES
NO
S403
S404
S407
COMMAND PROCESS AT SUBSTITUTION DESTINATION
COMMAND PROCESS AT SUBSTITUTION ORIGIN
ERROR PROCESS
END

FIG. 11

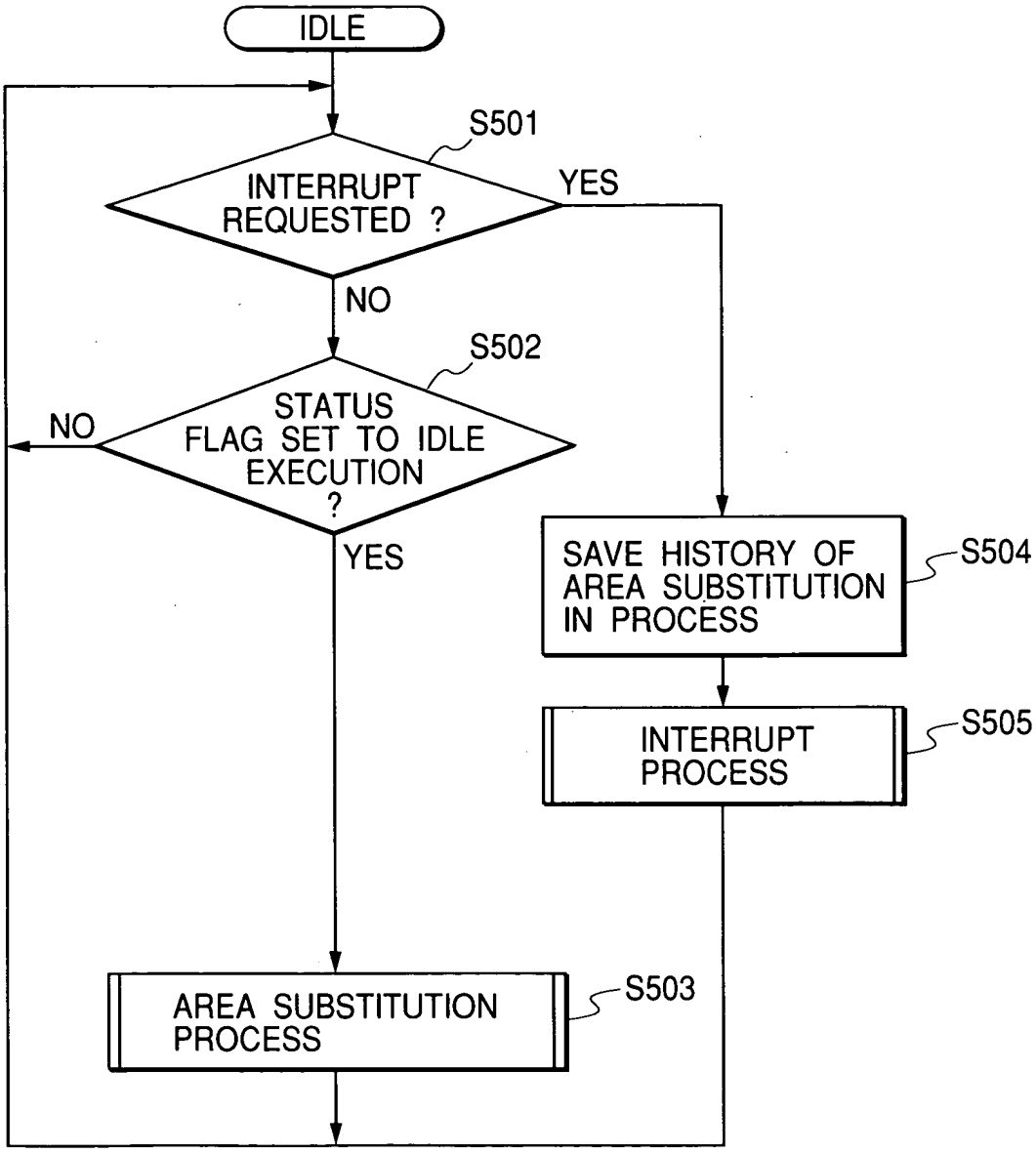
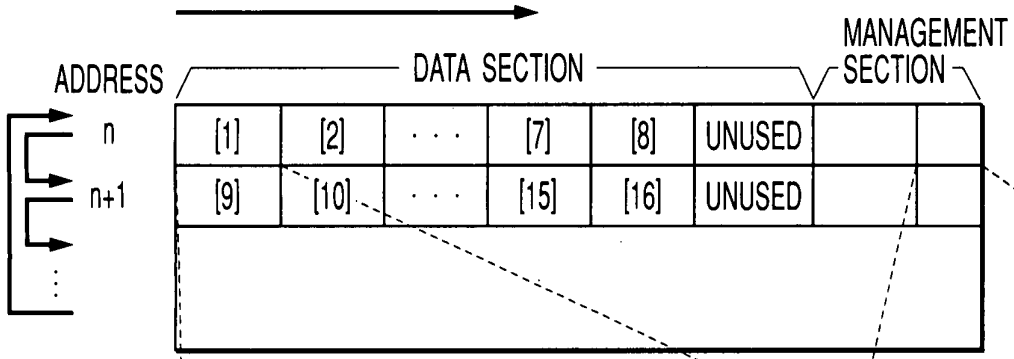

IDLE
S501
INTERRUPT REQUESTED ?
YES
NO
S502
STATUS FLAG SET TO IDLE EXECUTION ?
NO
YES
SAVE HISTORY OF AREA SUBSTITUTION IN PROCESS
S504
INTERRUPT PROCESS
S505
AREA SUBSTITUTION PROCESS
S503

FIG. 12(a)



PHYSICAL AREA NUMBER	START ADDRESS OF SUBSTITUTED	END ADDRESS OF SUBSTITUTED	REDUNDANT
0005h	000000h	001000h	

VALID FLAG							
[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
FFh	FFh	FFh	FFh	FFh	FFh	FFh	00h

- FFh=WRITING PERFORMED, 00h=NO WRITING PERFORMED
- THE LAST TABLE WHERE FFh IS WRITTEN IS VALID DATA IN THIS EXAMPLE, TABLE (7) IS VALID DATA
- AN OPERATION OF WRITING TABLE (9) WRITES DATA (INCLUDING VALID FLAGS) IN TABLE (9), AND THEN CLEARS DATA AT ADDRESS "n"

FIG. 12(b)

VALID TABLE	PHYSICAL AREA NUMBER	START ADDRESS OF SUBSTITUTED	END ADDRESS OF SUBSTITUTED
0007h	0005h	000000h	001000h

FIG. 13

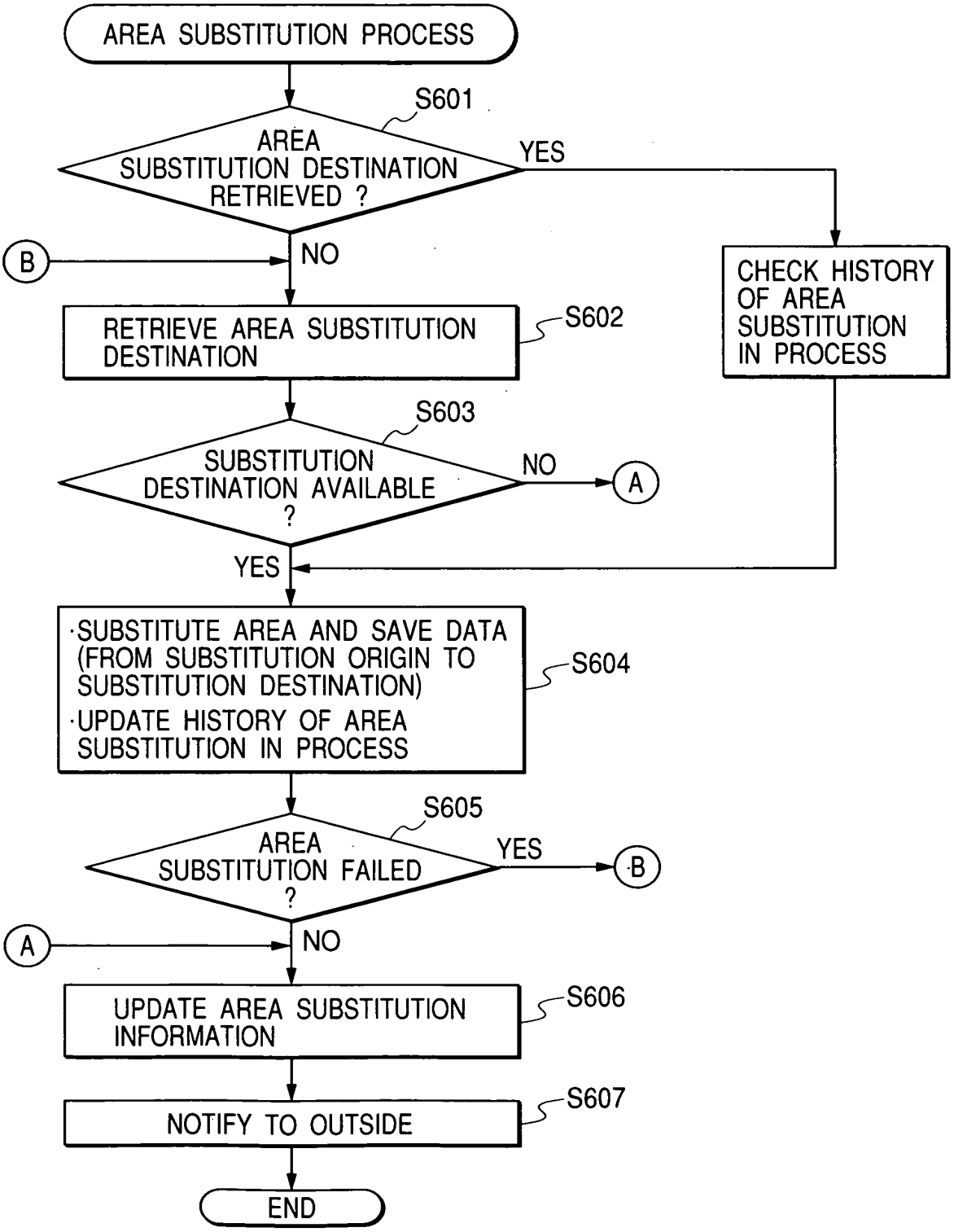

AREA SUBSTITUTION PROCESS
S601
AREA SUBSTITUTION DESTINATION RETRIEVED ?
YES
NO
B
CHECK HISTORY OF AREA SUBSTITUTION IN PROCESS
RETRIEVE AREA SUBSTITUTION DESTINATION
S602
S603
SUBSTITUTION DESTINATION AVAILABLE ?
NO
A
YES
·SUBSTITUTE AREA AND SAVE DATA (FROM SUBSTITUTION ORIGIN TO SUBSTITUTION DESTINATION)
·UPDATE HISTORY OF AREA SUBSTITUTION IN PROCESS
S604
S605
AREA SUBSTITUTION FAILED ?
YES
B
A
NO
UPDATE AREA SUBSTITUTION INFORMATION
S606
NOTIFY TO OUTSIDE
S607
END

FIG. 14

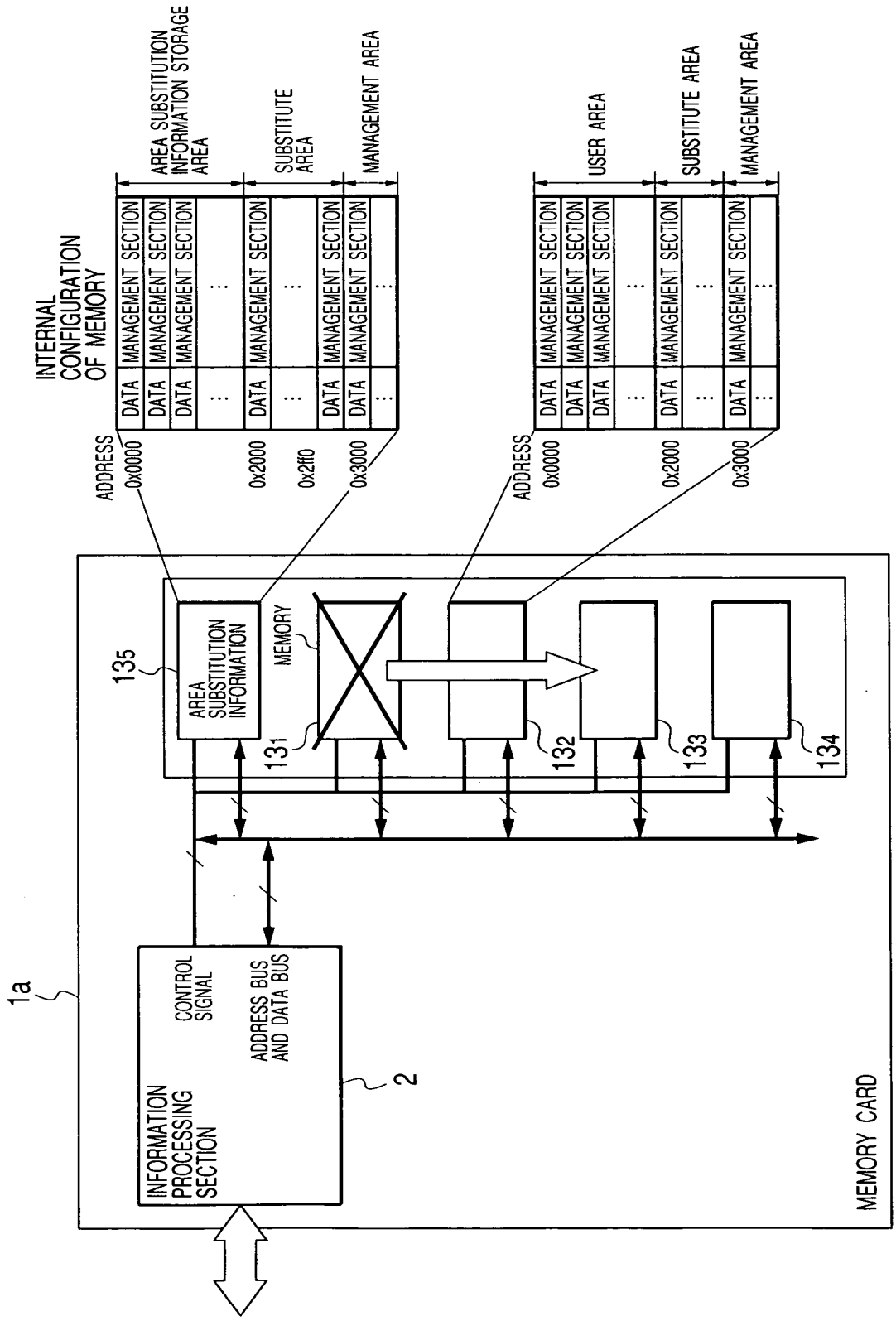

INTERNAL CONFIGURATION OF MEMORY
AREA SUBSTITUTION INFORMATION STORAGE AREA
SUBSTITUTE AREA
MANAGEMENT AREA
USER AREA
SUBSTITUTE AREA
MANAGEMENT AREA
ADDRESS
0x0000
0x2000
0x2ff0
0x3000
DATA
MANAGEMENT SECTION
1a
135
AREA SUBSTITUTION INFORMATION
MEMORY
131
132
133
134
INFORMATION PROCESSING SECTION
CONTROL SIGNAL
ADDRESS BUS AND DATA BUS
2
MEMORY CARD

FIG. 15

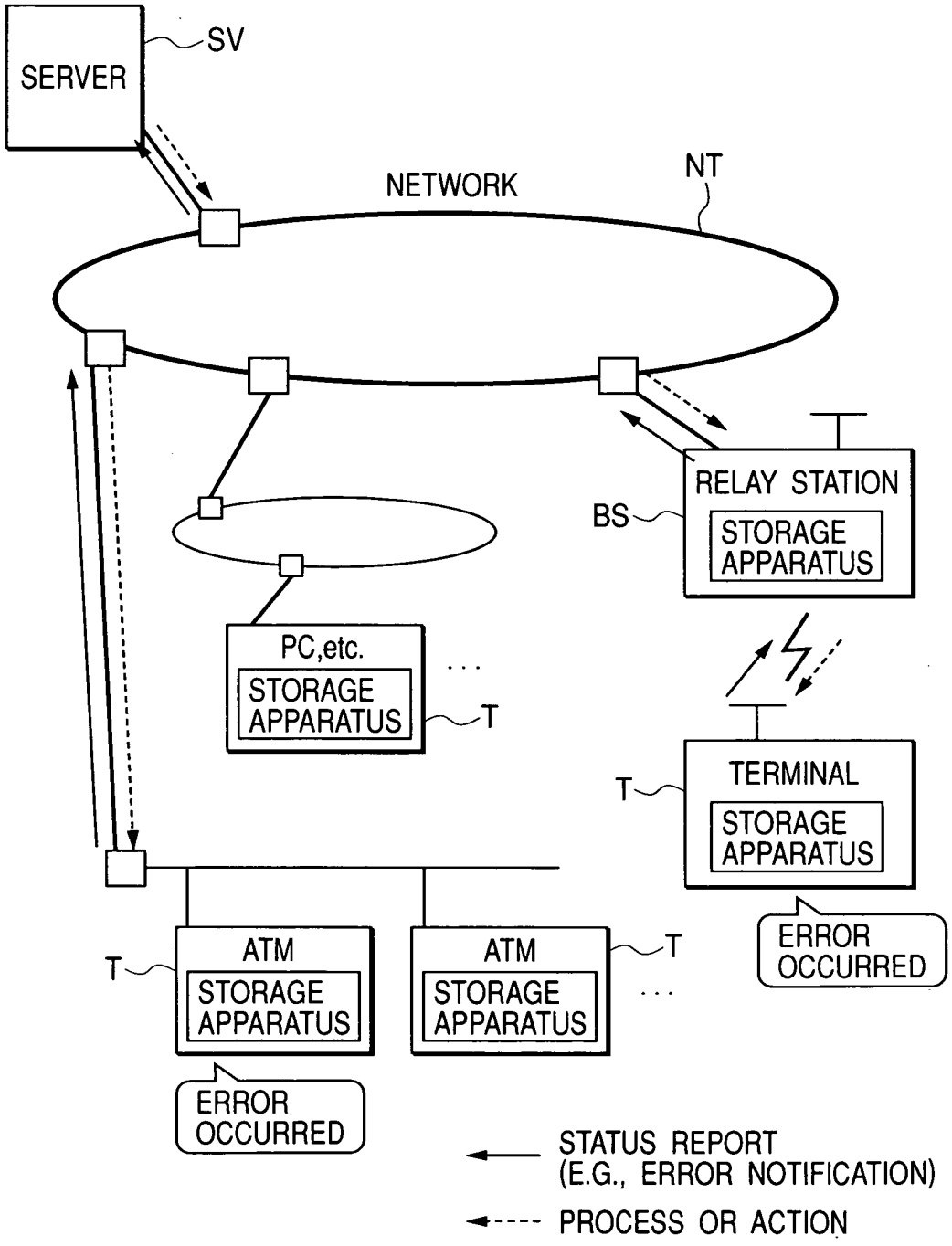
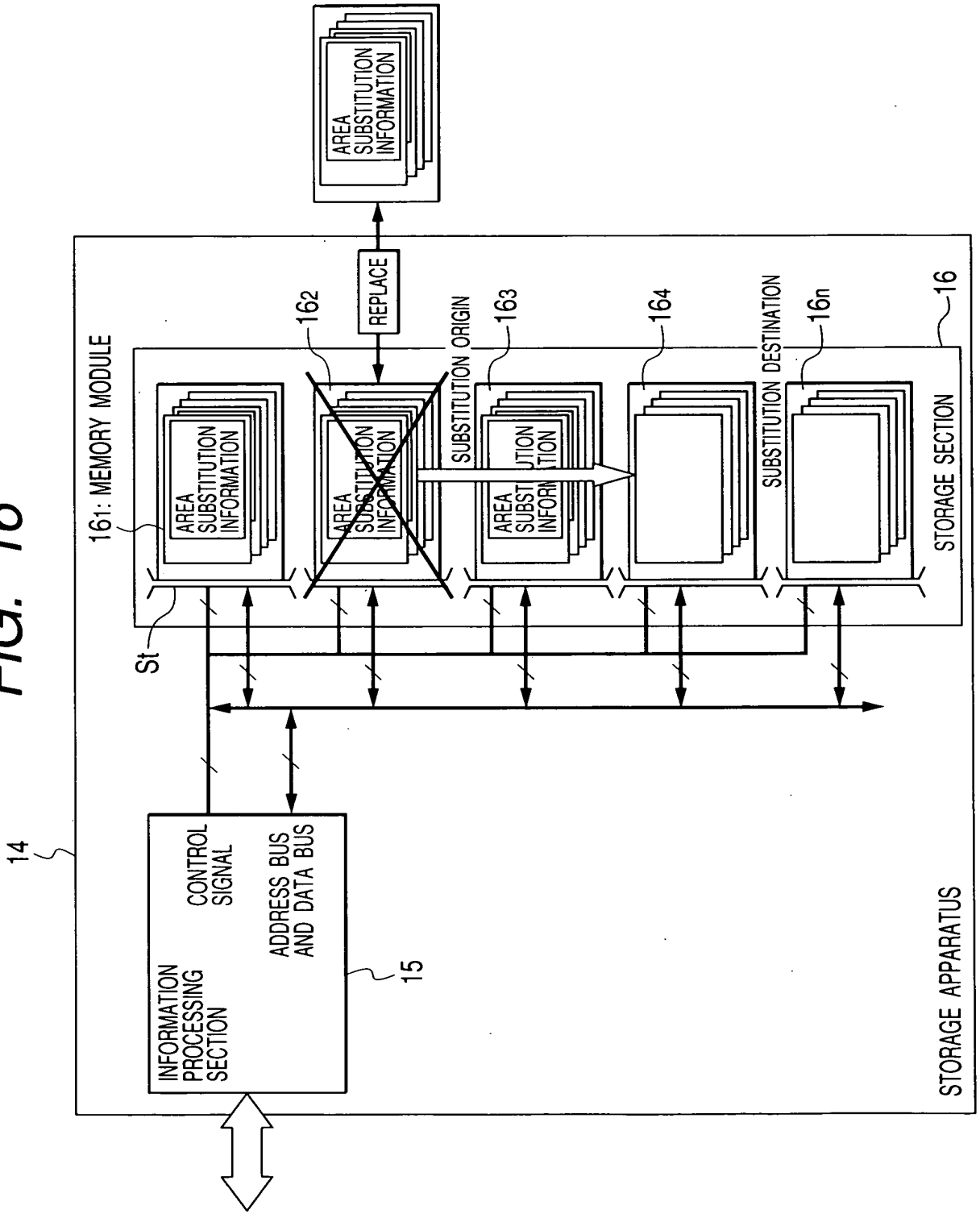

SERVER
SV
NETWORK
NT
RELAY STATION
BS
STORAGE APPARATUS
PC,etc.
STORAGE APPARATUS
T
TERMINAL
STORAGE APPARATUS
ATM
STORAGE APPARATUS
ERROR OCCURRED
STATUS REPORT (E.G., ERROR NOTIFICATION)
PROCESS OR ACTION

FIG. 16


AREA SUBSTITUTION INFORMATION
REPLACE
SUBSTITUTION ORIGIN
SUBSTITUTION DESTINATION
16
16n
16₄
16₃
16₂
16₁: MEMORY MODULE
STORAGE SECTION
St
14
CONTROL SIGNAL
ADDRESS BUS AND DATA BUS
INFORMATION PROCESSING SECTION
15
STORAGE APPARATUS